CODE / NAME: EC6801 WIRELESS COMMUNICATIONS 2 MARKS

EC6801 WIRELESS COMMUNICATION

UNIT I WIRELESS CHANNELS 9

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters- Coherence bandwidth – Doppler spread & Coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

UNIT II CELLULAR ARCHITECTURE 9

Multiple Access techniques - FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse - channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.

UNIT III DIGITAL SIGNALING FOR FADING CHANNELS 9

Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.

UNIT IV MULTIPATH MITIGATION TECHNIQUES 9

Equalisation – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver,

UNIT V MULTIPLE ANTENNA TECHNIQUES 9

MIMO systems – spatial multiplexing -System model -Pre-coding - Beam forming - transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Rappaport,T.S., “Wireless communications”, Second Edition, Pearson Education, 2010.

2. Andreas.F. Molisch, “Wireless Communications”, John Wiley – India, 2006.

REFERENCES:

1. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Cambridge University Press, 2005.
2. Upena Dalal, “ Wireless Communication”, Oxford University Press, 2009.

EC 6801- WIRELESS COMMUNICATIONS (Regulation 2013)

UNIT 1

PART-A

1. **What are the advantages of wireless communication? (APR/MAY2017)**
   1.Flexibility (wirelesses) 2. Ease of use. 3. Durability

2. **Give the equation for average large scale- path loss between the transmitter and receiver as a function of distance. . (NOV/DEC 2016)**
   $P_L(db) = 40\log d-(10\log G_t + 10\log G_r + 20\log h_t + 20\log h_r)$

3. **List the three basic propagation mechanisms? (Dec 2014)**
   1. Reflection 2.Diffraction 3.Scattering

4. **Mention the effects of fading.**
   1. Rapid changes in signal strength over a small travel distance or time interval.
   2. Random frequency modulation due to varying Doppler shifts on different multipath signals.
   3. Time dispersion caused by multipath propagation delays.

5. **Define coherence bandwidth. . (MAY/JUN 2016)**
   The coherence bandwidth is related to the specific multipath structure of the channel. The coherence bandwidth is a measure of the maximum frequency difference for which signals are still strongly correlated in amplitude.

6. **Describe the operation of free space propagation model?**
   It is a model which is used to predict received signal strength, when unobstructed line of sight path between transmitter and receiver.

7. **Compare small scale fading and large scale fading? (May/June 2013)**

S.NO	Small Scale Fading	Large Scale Fading
i)	The rapid fluctuations of the amplitudes, phases, or multipath delays of a radio signal over a short period of time or travel distance is known as small scale fading.	The rapid fluctuations of the amplitudes, phases, or multipath delays of a radio signal over a long period of time or travel distance is known as large scale fading.

8. **What is flat fading? Write its conditions.**
   If the mobile radio channel has a constant gain and linear phase response over a bandwidth which is greater than the bandwidth of the transmitted signal, then the received signal will undergo flat fading.
   Conditions: BW of signal<<BW of channel

Symbol period>>Delay spread

9. Distinguish time dispersion and frequency dispersion?

The received signal has a longer duration than that of the transmitted signal, due to the different delays of the signal paths. This is known as time dispersion.

The received signal has a larger bandwidth than that of the transmitted signal, due to the different Doppler shifts introduced by the components of the multipath. This is known as frequency dispersion.

10. Define coherence time. In what way does this parameter decide the behavior of Wireless channel.

Coherence time (T_c) is the time duration over which the two received signals have a strong potential for an amplitude correlation.

$$T_c = 1/f_m$$

11. What is frequency selective fading?

If the channel possesses a constant gain and linear phase response over a bandwidth that is, smaller than the bandwidth of transmitted signal, then the channel creates frequency selective fading on the received signal.

Conditions: BW of signal>BW of channel

Symbol period< Delay

12. Predict the need for propagation model?

Propagation models have traditionally focused on predicting the average received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in close spatial proximity to a particular location. Propagation models that predict the mean signal strength for an arbitrary transmitter receiver separation distance are useful in estimating the radio coverage area of a transmitter.

13. Compare Doppler shift and Doppler spread.

The shift in received signal frequency due to motion is called the Doppler shift. The Doppler spread is defined as the range of frequencies over which the received Doppler spectrum is essentially non-zero.

14. Distinguish coherence time and coherence bandwidth.

The coherence bandwidth is related to the specific multipath structure of the channel. The coherence bandwidth is a measure of the maximum frequency difference for which signals are still strongly correlated in amplitude.

This bandwidth is inversely proportional to the rms value of time delay spread.

The coherence timer is defined as the required time interval to obtain an envelope correlation of 0.9 or less.

15. Define Snell's law.

Snell's law states that the ratio of the sine of the angle of incidence and refraction is equivalent to the ratio of phase velocities in the two media, or equivalent to the reciprocal of the ratio of the indices of refraction.

16. Differentiate Fast fading & slow fading.

The channel impulse response changes rapidly within the symbol duration. This type of channel is called fast fading channel.

The channel impulse response changes at a rate much slower than the transmitted baseband signal. This type of channel is called slow fading channel.

17. Explain frequency selective fading? Write its conditions.

If the channel possesses a constant gain and linear phase response over a bandwidth that is, smaller than the bandwidth of transmitted signal, then the channel creates frequency selective fading on the received signal.

Conditions: BW of signal>BW of channel

Symbol period< Delay

18. Interpret link budget equation.

A link budget equation: $P_{rx} = P_{tx} + G_{tx} - L_{tx} - L_{fs} - L_m + G_{rx} - L_{rx}$

PART-B

1. **Outline the time variant two-path model of a wireless propagation channel. (APR/MAY 2017).**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:120,125]

2. **Explain fading effects due to multipath time delay spread and fading effects due to Doppler spread. (APR/MAY 2017)**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:203-205,125]

3. **In free space propagation describe how the signal are affected by reflection diffraction and scattering. (MAY/JUN 2016)**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:114,126,115].

4. **Discuss in detail the various parameters involved in mobile multipath channels. (MAY/JUN 2016)**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:203-205,125]

5. **Construct the narrow band modeling methods for Short scale fading & Long scale fading. (May/June 2013)**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:205-210]

6. **Explain the free space path loss & derive the gain expression. (May/June 2012)**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:107-205,110]

7. **Describe in detail about two Ray Model propagation mechanism. (May/June 2012)**Ref: "Wireless Communication" by S.Rappaport [Page.no:120-125]

8. **Discuss any two methods of diffraction by multiple screens. (Nov/Dec 2011)** Ref: "Wireless Communication" by S.Rappaport [Page.no:126-135]

UNIT 2

PART-A

1.Why is cellular concept used for mobile telephony? (APR/MAY 2017)

A cellular network or mobile network is a communication network where the last link is wireless. The network is distributed over land areas called cells, each served by at least one fixed-location transceiver, but more normally three cell sites or base transceiver stations.

2. **Define coherence time. (NOV/DEC2016)**

Coherence time (T_c) is the time duration over which the two received signals have a strong potential for an amplitude correlation.

3. **Distinguish forward and reverse channel?**

Forward channel is a radio channel used for transmission of information from base station to mobile. Reverse channel is a radio channel used for transmission from mobile to base station.

4. **Describe the function of control channel? What are the types?**

The function of control channel is to transmit call setup, call request, call initiation and Control. There are two types of control channels,

a. Forward control channel
b. Reverse control channel

5.What is channel assignment and list the types?

For efficient utilization of radio spectrum a frequency reuse scheme with increasing capacity and minimizing interference is required. For this channel assignment is used. The types of channel assignment are:

a. Fixed channel assignment
b. Dynamic channel assignment.

6.Define hand off and mode of hand off.

A hand off refers to the process of transferring an active call or data session from one cell in a cellular network to another or from one channel in a cell to another. A well implemented hand off is important for delivering uninterrupted service to a caller or data session user. Modes of hand off are:

a. MCHO – Mobile Controlled Hand off
b. NCHO – Network Controlled Hand off
c. MAHO – Mobile Assisted Hand off

7. What is frequency reuse ratio?

If the cell size and the power transmitted at the base stations are same then co-channel interference will become independent of the transmitted power and will depend on radius of the cell (R) and the distance between the interfering co-channel cells (D). If D/R ratio is increased, then the effective distance between the co-channel cells will increase and

interference will decrease. The parameter Q is called the frequency reuse ratio and is related to the cluster size. For hexagonal geometry

8. Define sectoring?

Sectoring is a technique for decreasing co-channel interference and thus increasing the system performance by using directional antennas.

9. Write short notes on cell splitting.

Cell splitting is the process of subdividing congested cells into smaller cells each with its own base stations and a corresponding reduction in antenna height and transmitter power. It increases the capacity of cellular system.

10. What is meant by frequency reuse?

If an area is served by a single Base Station, then the available spectrum can be divided into N frequency channels that can serve N users simultaneously. If more than N users are to be served, multiple BSs are required, and frequency channels have to be reused in different locations. Since spectrum is limited, the same spectrum has to be used for different wireless connections in different locations. This method of reusing the frequency is called as frequency reuse.

11. In a cellular network, among a handoff call and a new call, which one is given priority?

Handoff call have more priority than new call. The handoff call will shift automatically from one base station to another base station.

12. Define co-channel interference.

CCI – Co-channel interference is the interference between signals from co-channel cells.

13. List the types of hand off.

Types of handoff are:

i. Hard hand off – Mobile monitors BS and new cell is allocated to a call with strong signal. ii. Soft hand off – MS with 2 or more calls at the same time and

find which is the Strongest signal BS, the MSC automatically transfers the call to that BS.

14. Relate Cell & Cluster.

For a large geographic coverage area, a high powered transmitter therefore has to be used. But a high power radio transmitter causes harm to environment. Mobile communication thus calls for replacing the high power transmitters by low power transmitters by dividing the coverage area into small segments, called cells. Each cell uses a certain number of the available channels and a group of adjacent cells together use all the available channels. Such a group is called a cluster.

15. What are the techniques used to expand the capacity of cellular system?

Cell splitting – Cell-splitting is a technique which has the capability to add new smaller cells in specific areas of the system. i.e. divide large cell size into small size. **Sectoring** – use of directional antennas to reduce Co-channel interference.

Coverage Zone approaches – large central BS is replaced by several low power transmitters on the edge of the cell.

16. Define Grade of service.

Grade of service is defined as the measure of the ability of a user to access a trunked system during

the busiest hour.

17. Discuss in detail about multiple access techniques?

Multiple access is a signal transmission situation in which two or more users may wish to communicate simultaneously with each other using the same propagation channel.

18. State advantages of CDMA over FDMA.

S.NO	FDMA	CDMA
1	Narrow band system	Wide band system
2	Hard handoff	Soft handoff
3	Used for voice and data transmission.	Used for digital voice signals & multimedia service

PART-B

1. Explain about co-channel interference and adjacent channel interference. Describe the techniques to avoid interference. (NOV/DEC 2016)

Ref: "Wireless Communication" by S.Rappaport [Page.no:67-77]

2. **Distinguish Code Division Multiple Access (CDMA) performance with TDMA. (May/Jun 2012)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:455-461]

3. **Illustrate in detail how to improve coverage and channel capacity in cellular systems. (MAY/JUN 2016)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:86-96]

4. **Discuss the principle of direct sequence spread spectrum technique. (Nov/Dec2011)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:331-334]

5. **What is orthogonal frequency division multiplexing? Explain OFDM technique and mention its merits, demerits and application. (May/Jun 2012) (May/Jun 2013)**
   Ref: "Wireless Communication" by Murali Babu [Page.no:6.2-6.7& 6.19]

6. **Explain about co-channel interference and system capacity with neat diagram. (NOV/DEC 2015)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:67-77]

7. **Distinguish Frequency Division Multiple Access (FDMA) performance with TDMA. (May/Jun 2012) (May/Jun 2013)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:451-459]

8. **Summaries the features of various multiple access techniques used in wireless communication. State the advantage and disadvantages of each technique. (MAY/JUN 2016)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:451-461]

UNIT-3

PART-A

1. **Define QPSK? (NOV/DEC 2015)**
   The Quadrature Phase Shift Keying (QPSK) is a 4-ary PSK signal. The phase of the carrier in the QPSK takes 1 of 4 equally spaced shifts. Two successive bits in the data sequence are grouped together.
   1 symbol = 2 bits
   This reduces bit rate and bandwidth of the channel.
   Coherent QPSK = 2 x coherent BPSK system

2. **List out the advantages of QPSK.**
   i) Low Error Probability. ii) Very Good Noise Immunity.
   iii) Carrier power remains constant.

3. Define π/4 QPSK Modulation. (APR/MAY 2016)

In a π/4 QPSK modulator, signaling points of the modulated signal are selected from two QPSK constellations which are shifted by π/4 with respect to each other.

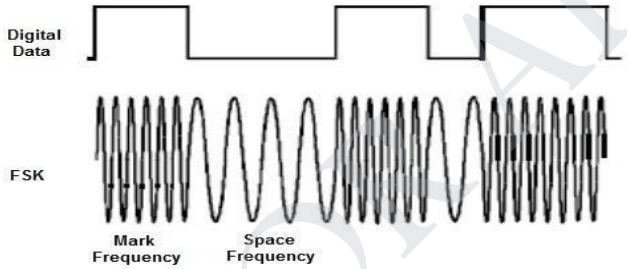
4. What is orthogonal frequency division multiplexing?

OFDM splits the information into N parallel streams which are modulated by N distinct carriers and then transmitted. In order to separate the subcarriers by the receiver, they have to be orthogonal.

5. Mention the need for equalization. (NOV/DEC 2016)

Equalization can be used to compensate the Inter Symbol Interference created by multipath within time dispersion channel.

6. Draw the BFSK signal.



7. Why GMSK is preferred for multiuser in cellular communication?

It is a simple binary modulation scheme. Premodulation is done by Gaussian pulse shaping filter, so side lobe levels are much reduced. GMSK has excellent power efficiency and spectral efficiency than FSK. For the above reasons GMSK is preferred for multiuser, cellular communication.

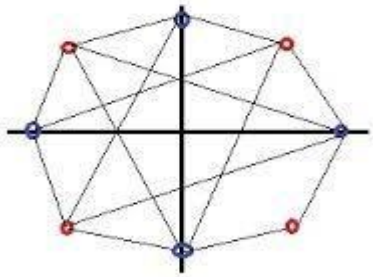
8. Explain in detail about the M-array systems.

In digital modulations instead of transmitting one bit at a time, two or more bits are transmitted simultaneously. This is called M-array systems.

9. Compare power efficiency and Bandwidth efficiency?(APR/MAY 2017)

Power efficiency describes the ability of a modulation technique to preserve the fidelity of the digital message at low power levels.

10. Plot the Constellation diagram of π/4 QPSK.



All the possible states of pi/4 QPSK Constellation

11. What is windowing?

In communication window function is a mathematical function that is zero valued outside of some chosen interval and is the process of taking a small subset of a larger dataset for processing and analysis.

12. State OQPSK? Mention the advantage of OQPSK.

To improve the peak-to-average ratio in QPSK is to make sure that bit transition for in-phase and quadrature phase component different time instants. This is called OQPSK.

13. Give the function of Gaussian filter in GMSK.

The Gaussian filter that is used before the modulator to reduce the transmitted bandwidth of the signal. GMSK use as less bandwidth then conventional FSK.

14. Define PAPR in OFDM?

PAPR can be defined as the relation between the maximum power of a sample in a transmit OFDM symbol and its average power.

15. Find the 3-dB bandwidth for a Gaussian low pass filter used to produce 0.25 GMSK with a channel data rate of R_b = 300 Kbps. Ans: $T=1/R_{b;}$ = 153.9 Khz.

16. Why is MSK referred to as fast FSK?

MSK is a special type of binary continuous phase frequency shift keying, where in the peak frequency deviation is equal to ¼ the bit rate and modulation index =h=1/2. This leads to the minimum frequency spacing that makes the two FSK signals orthogonal to each other. MSK sometimes referred to as fast fsk as the frequency spacing use is only half as much as that used in conventional non-coherent FSK**.**

17. What is group delay?

In signal processing, group delay is the time delay of the amplitude envelopes of the various sinusoidal components of a signal through a device under test, and is a function of frequency for each component. Phase delay, in contrast, is the time delay of the phase as opposed to the time delay of the amplitude envelope.

18. Differentiate delay dispersion and frequency dispersion.

S.no	Delay dispersion	Frequency dispersion
1	Delay dispersion are due to echoes of the transmit signal arriving with different delays.	Frequency dispersion are due to Doppler.
2	At high data rates, delay dispersion is the main reason for signal distortions errors.	At low data rates, Doppler effect is the main reason for signal distortion errors.

PART-B

1. **Derive the expression for MSK signal as special type of continuous phase FSK signal. (Nov / Dec 2015)**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:314-318]

2. **Write short notes on (i) π/4 QPSK (ii) OQPSK.**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:305-311]

3. **Draw the basic arrangement of Orthogonal FDM transceivers and discuss its overall operation. (Nov / Dec 2015)**

   Ref: "Wireless Communication" by S.Muralibabu [Page.no:6.1-6.8]

4. **Discuss in detail about Windowing and PAPR in OFDM systems.**

   Ref: "Wireless Communication" by S.Muralibabu [Page.no:6.12-6.15]

5. **Explain the detail about GMSK transmission and reception with necessary block diagrams. (Nov / Dec 2015)**

   Ref: "Wireless Communication" by S.Rappaport [Page.no:318-322]

6. **A zero mean sinusoidal message is applied to a transmitter that radiates an AM signal with 10 KW power. Compute the carrier power if the modulation index is**

0.6. What percentage of the total power is in the carrier? Calculate the power in each side band. (Nov / Dec 2015)

Solution:

$$\tfrac{1}{2}(P_{am}-P_c) = 0.5*(10-8.47) = .0765kw$$

Ref: "Wireless Communication" by S.Janani Solved question [Page.no:11-12]

7. **Describe the Error probability performance in all the fading channels.**

Ref: "Wireless Communication" by S.Moliisch" [Page.no:232-242]

8. **Discuss in detail about the structure of a wireless communication link.**

Ref: "Wireless Communication" by S.Muralibabu [Page.no:5.1-5.8]

9. **Compare and contrast the constellation, signal space diagram, error performance of QPSK,**
MSK, GMSK, OQPSK and π/4 QPSK. (NOV/DEC 2016)

Ref: "Wireless Communication" by S.Rappaport [Page.no:300-308]

UNIT 4
PART A

1. **Distinguish linear and non linear equalizer? (Nov/Dec 2016)**

Linear equalizer: the current and past values of the received signal are linearly Weighted by the filter coefficients and summed to produce the output. No feedback path is used. Simple and easy to implement. Not suitable for severely distorted Channel. Noise power signal is enhanced.

Nonlinear equalizer: If the past decisions are correct, then the ISI contributed by present symbol can be cancelled exactly, feedback path is used. Suitable for severely distorted channel. Noise power signal is not enhanced. Complex in structure. Channels with low SNR. Suffers from error propagation.

2. **Define adaptive equalization. (May/June 2016)**

To combine Inter Symbol Interference, the equalizer coefficients should change according to the channel status so as to break channel variations. Such an equalizer is called an adaptive equalizer since it adapts to the channel variations.

3. **What are the factors used in adaptive algorithms? (Nov/Dec 2015)**

- Rate of convergence
- Maladjustments
- Computational complexity

4. **Differentiate selection diversity and combining diversity.**

S.NO	SELECTION DIVERSITY	COMBINING DIVERSITY
1.	The best signal is selected and processed while all the other signals are discarded.	All signals are combined before processing and the combined signal is decoded.
2	Simple circuits are used.	At individual receiver phasing circuits are needed.
3	None of the signal is not in acceptable SNR.	It works well.

5. **What is the need for diversity in multipath propagation? (Nov/Dec 2010)**

Diversity is used to compensate the fading channel impairments and is usually implemented by using two or more receiving antennas. Diversity improves transmission performance by making use of more than one independently faded version of the transmitted signal. The principle of diversity is to ensure that the same information reaches the receiver on statistically independent channels.

6. **Differentiate Micro diversity and Macro diversity.**

Micro diversity

- Used to reduce small scale fading effects. ➢Multiple reflection causes deep fading.
- BS-MS are separated by small distance

Macro diversity

- Used to reduce small scale fading effects.
- Deep shadow caused fading.
- BS-MS are separated by small distance.

7. **Explain the necessity of an equalizer?**

Equalization can be used to compensate the Inter Symbol Interference created by multipath within time dispersion channel.

8. **Where DFE are used?**

The DFE is particularly is useful for the channel with severe amplitude distortion and has been widely used in wireless communications.

9. **Define ZF equalizer.**

In zero forcing equalizer the equalizer co-efficient are chosen to force the samples of the combined channels and equalizer impulse response to zero.

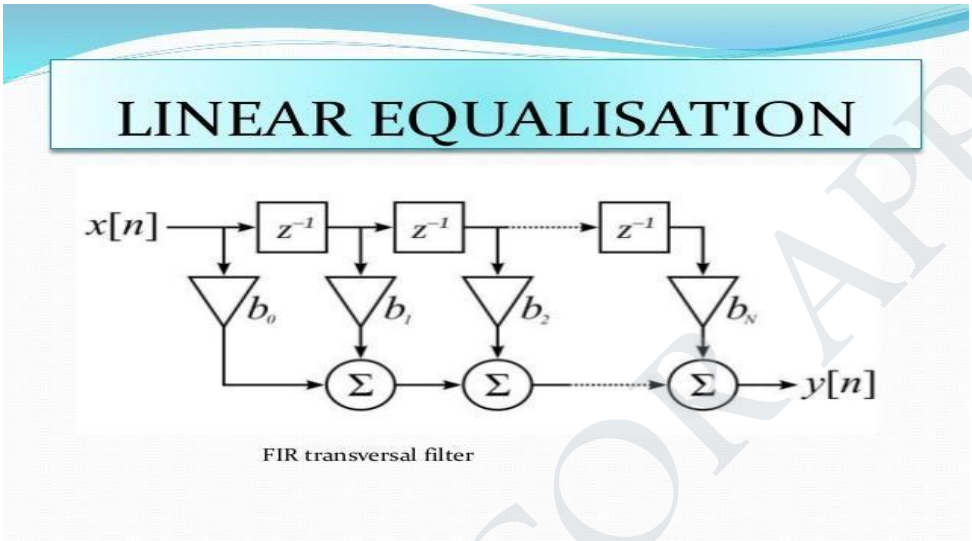
10. What is Macro diversity?

It is a kind of space diversity scheme using several antennas or transmitter antennas for transferring the same signals. The distance between the transmitters is longer than the wavelength.

11. List the benefit of RAKE receiver?

Reduces the multipath interference by combining direct and reflected signals in the receiver.

12. Draw the structure of a linear transversal equalizer.



13. Name the basic algorithm used for adaptive equalization.

i. Zero forcing algorithm.
ii. LMS algorithm
iii. RLS algorithm.

14. Name the various non linear equalization methods.

- Decision feedback equalization.
- Maximum likelihood symbol detection
- Maximum likelihood sequence estimation.

15. Mention the advantages of LMS algorithm.

- It maximizes the signal to distortion at its output within the constraints of the equalizer filter length.
- Low computational complexity.
- Simple program.

16. Write the basic principle of DFE.

The basic principle of decision feedback equalization (DFE) is that , if the vale of the information symbols already detected are known then ISI contributed by these symbols

can be cancelled exactly by subtracting the past symbol values with appropriate weighting from the equalizer output.

17. Which type of equalizer is IIR filter?

When an equalizer has both feed forward and feedback taps, its transfer function is rational function of z inverse. Then it is called an II filter.

18. What is meant by frequency diversity?

In frequency diversity the same signal is transmitted at two or more different frequencies. These carrier frequencies get un-correlated to each other, so they will not experience the same fades. To make them least correlated these carrier frequencies are separated by more than one coherence bandwidth of the channel. This will improve the overall system performance.

PART-B

1. **Explain in detail the various factors to determine the algorithm for adaptive equalizer. Also derive the LMS algorithm for adaptive equalizer? (Nov/Dec 2016)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:359-364& 374]
2. **Distinguish in detail about linear and non linear equalizers. (May/June 2016)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:366-372]
3. **Discuss in detail about the frequency diversity with neat sketches.(Nov/Dec 2015)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:390]
4. **Describe the Error probability in fading channels with diversity reception. (May/June 2016)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:268-370]
5. **Write short notes on Space diversity, frequency diversity, Polarization diversity, Time diversity. (Nov/Dec 2014)**
   Ref: "Wireless Communication" by S.Rappaport [Page.no:387-391]
6. **With neat block diagram, explain the principle of micro diversity and macro diversity.** Ref: "Wireless Communication" by S.RamsehBabu [Page.no:366-372]
7. **With relevant diagrams explain RAKE receiver. Also discuss how time diversity is achieved in a CDMA technique using RAKE receiver. (Nov/Dec 2016)**

Ref: "Wireless Communication" by S.Rappaport [Page.no:391-393]

8. **Derive the mean square error for a generic adaptive equalizer.(Nov/Dec 2015)**Ref: "Wireless Communication" by S.Rappaport [Page.no:359-364]

UNIT 5
PART A

1. **Define antenna diversity. .(Nov/Dec 2015)**

Antenna diversity is a transmission method using more than one antenna to receiver or transmits signals along different propagation paths to compensate for multipath interferences.

2. **How does spatial multiplexing work? .(Nov/Dec 2016)**

Spatial multiplexing uses MEAs at the TX for transmission of parallel data streams. An original high-rate data stream is multiplexed into several parallel streams, each of which is sent from one transmit antenna element. A basic condition is that the number of receive antenna elements is at least as large as the number of transmit data streams.

3. **What is transmitting diversity? (Apr/May 2016)**

Diversity effect is achieved by transmitting signals from several transmit antenna. Two main cases are considered in transmit diversity. They are, 1.Transmitter diversity with the CSI (Channel State information) 2. Transmitter diversity without the CSI (Channel State information).

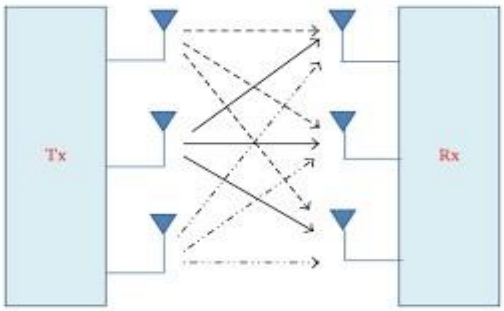
4. **What is meant by CSI? (Nov/Dec 2015)**

Channel state information (CSI) is information which presents the state of communication link from Transmit Source to Receiver Source.

5. **Define capacity of a fading channel.**

Channel capacity repents the fundamental limitation for information transmission over any communication channel.

6. Draw the structure of MIMO system model.



7. Define D-BLAST.

The symbols which are to be transmitted are arranged on the diagonals of the space-time transmission matrix where elements under diagonals are padded with zeros.

8. Write short notes on Receiver diversity.

Receiver diversity uses two separate, collocated antennas for receive functions. Such a configuration eliminates the need for a duplexer and can protect sensitive receiver components from the high power used in transmitter side.

9. Describe the operation of smart antenna systems?

Smart antennas are antenna arrays with smart signal processing algorithms used to identify spatial signal signatures such as direction as addiction of arrival of the signal and used to calculate beam forming vectors to track and locate antenna beam on mobile target.

10. Define bit error rate?

The rate at which errors occur in the transmission of digital data.

11. Distinguish ergodic capacity and outage capacity of a flat fading channel?

Ergodic capacity is the expected value of the capacity taken over all realization of the channel. Outage capacity is the minimum transmission rate that is achieved over a certain fraction of time.

12. What is MIMO system?

MIMO systems are systems with Multiple Element Antennas (MEAs) at both transmitter and receiver. MIMO system offers high data rates and lower error rates.

13. Describe spatial multiplexing?

Spatial multiplexing uses MEAs at the TX for transmission of parallel data streams. An original high-rate data stream is multiplexed into several parallel streams, each of which is sent from one transmit antenna element. A basic

condition is that the number of receive antenna elements is at least as large as the number of transmit data streams.

14. Define beam forming.

Beam forming or smart antenna system uses phased array of antennas for transmitter and receiver. It can be used in any antenna system to create a required antenna directive pattern to give the required performance under the given conditions.

15. Define V- BLAST.

Incoming data stream is demultiplexed into N streams each of which is encoded and modulated independently and sent on an antenna of its own.

16. Explain the concept of transmitter beam forming?

Aligning the transmit signal in the direction of the transmit antenna array pattern is called transmit beam forming.

17. Define precoding.

Precoding scheme is designed to minimize the mean-squared error between the transmitted and received data with a per-user power constraint. Precoding allows to perform many complex processing at BS or Access Point(AP).It reduces computational complexities and provides better performance.

18. What is massive MIMO?

Massive multiple-input, multiple-output, or massive MIMO, is an extension of MIMO, which essentially groups together antennas at the transmitter and receiver to provide better throughput and better spectrum efficiency

PART-B

1. **Determine the capacity of frequency selective fading channels and explain the concept of water filling water pouring. (Nov/Dec 2015)**

   Ref: “Wireless Communication” by S.Rappaport [Page.no:207-208]

2. **Calculate the capacity of MIMO system flat fading and non fading channels. (Nov/Dec 2015)**

   Ref: “Wireless Communication” by S.Rappaport [Page.no:464-470]

3. **What is known as CSI? Explain in detail.**

   Ref: “Wireless Communication” by MuraliBabu [Page.no:10.8-10.11]

4. **What is mean by spatial multiplexing? Explain about receiver diversity**

Ref: "Wireless Communication" by MuraliBabu [Page.no:10.4-10.8]

5. **Determine the capacity of slow fading channel and prove that the outage probability for receiver diversity system with L receive antennas r is $P_{out}(R) = (2^R-1)^L$**

$LSNR^L$, Where R is the data rate. (NOV/DEC 2105)

Solution:

Ref: "Wireless Communication" by S.Janani Solved question. [Page.no:15]

6. **With neat diagram explain the system model for multiple input multiple output system and discuss in detail the classification of algorithms for MIMO based system.(NOV/DEC 2016)**

Ref: "Wireless Communication" by MuraliBabu [Page.no:9.1-9.5]

7. **Differentiate the operation of transmit & receiver diversity and its types.**

Ref: "Wireless Communication" by MuraliBabu [Page.no:10.1-1-8]

8. **Explain the following terms i) BLAST receiver ii) Beam forming**

Ref: "Wireless Communication" by MuraliBabu [Page.no:9.13-9.16]

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PART B — (5 × 16 = 80 marks)

... of power, which is applied to a unity

(b) (i) Derive the expressions for Cellular CDMA schemes for both noise limited and interference limited scenarios. (10)

(ii) Consider Global System for Mobile, which is a TDMA/FDD system that uses 25 MHz for the forward link, which is broken into radio channels of 200 MHz. If 8 speech signals are supported on a single radio channel and if no guard band is assumed find the number of simultaneous users that can be accommodated in GSM. (2)

(iii) If GSM uses a frame structure where each frame consists of eight time slots, and each time slot contains 156.25 bits, and data is transmitted at 270.833 kbps in the channel, find (1) the time duration of a bit (2) the time duration of a slot (3) the time duration of a frame and (4) how long must a user occupying a single time slot wait between two successive transmissions? (4)

13. (a) (i) Why are constant envelope modulation schemes such as MSK and GMSK used in a wireless communication system? Compare and contrast these two modulation techniques. (8)

(ii) Describe OFDM scheme and state the reason behind using cyclic prefix in OFDM scheme. What is PAPR? Why is it normally larger in a OFDM technique? (8)

Or

(b) (i) Discuss the error performance of different modulation schemes in fading channels. (10)

(ii) What is Offset–QPSK? What is its advantage? Describe the Offset–QPSK scheme. (6)

14. (a) (i) Describe the role played by Equalisation and diversity as Multipath mitigation techniques. Compare and contrast these two techniques. (10)

(ii) Consider the design of the US Digital Cellular equalizer, where f = 900 MHz and the mobile velocity v = 80 km/hr, determine the maximum Doppler shift, the coherence time of the channel and the maximum number of symbols that could be transmitted without updating the equalizer assuming that the symbol rate is 24.3 k symbols/sec. (6)

Or

(b) (i) With a sketch, describe RAKE receiver. (6)

(ii) Assume four branch diversity is used, where each branch receives an independent Rayleigh fading signal. If the average SNR is 20 dB, determine the probability that the SNR will drop below 10 dB. Compare this with the case of a single receiver without diversity. (4)

(iii) Derive an expression for performance improvement due to Maximal Ratio combining. (6)

15. (a) Discuss in detail, the capacity in fading and non–fading channels. (16)

Or

(b) (i) Describe MIMO systems with emphasis on their requirement in a wireless communication environment. (8)

(ii) Describe the concepts of Pre–coding and Beam forming. (8)